

*USING CONDITIONAL DISCRIMINATION TRAINING TO PRODUCE
EMERGENT RELATIONS BETWEEN COINS AND THEIR VALUES IN
CHILDREN WITH AUTISM*

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The current study evaluated the effects of conditional discrimination (listener) training with coins on the emergence of novel stimulus relations, textual behavior, tacts, and intraverbals. Two preschoolers with autism were taught 3 relations among coins, their names, and values. After initial training, 4 relations emerged for the first participant and 7 for the second participant, suggesting that this technology can be incorporated into educational curricula for teaching prerequisite money skills to children with autism.

Key words: money, autism, coin equivalence, emergent relations, stimulus equivalence

One of the outcomes of matching-to-sample (MTS) procedures is that topographically dissimilar stimuli may become substitutable for one another. Thus, after teaching a set of relations among stimuli, untrained relations may emerge and novel behaviors may be evoked. For example, when participants are taught to select pictures and printed words when given the same dictated names (i.e., listener training), they may be able to match pictures and printed words without being trained to do so directly, and may also be able to engage in novel speaker behavior by labeling the pictures and printed words (Sidman, 1994). Although stimulus equivalence procedures have been used to produce a wide range of novel behavior in individuals with disabilities, including autism (e.g., Groskreutz,

Karsina, Miguel, & Groskreutz, 2010; LeBlanc, Miguel, Cummings, Goldsmith, & Carr, 2003; Miguel, Yang, Finn, & Ahearn, 2009), this specific method of training and testing for novel relations has yet to be integrated fully into early intensive behavioral intervention curricula and disseminated to practitioners (Rehfeldt, 2011).

In a demonstration of how stimulus equivalence could be used to produce novel coin relations, McDonagh, McIlvane, and Stoddard (1984) taught one participant with intellectual disabilities to select pictures of coins and pictures of coin combinations given their printed price via MTS, and observed the emergence of the untrained relation between coins and coin combinations. Likewise, Stoddard, Brown, Hurlbert, Manoli, and McIlvane (1989) established coin equivalence with three individuals with intellectual disabilities. Their procedures varied across participants, but involved the use of matching and exclusion to produce the selection of new coin combinations in the presence of printed prices and coin combinations that served as samples in MTS

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tasks. The authors suggested these to be promising methods for teaching money skills to individuals with disabilities, because all participants demonstrated new performances without the need for explicit training.

Although a few studies have explored the applicability of stimulus equivalence for teaching money skills, none of these included children with autism as participants. Therefore, the purpose of the current study was to evaluate the use of conditional discrimination training to generate coin equivalence in children with autism, including the emergence of speaker behavior. The emergence of untrained relations between coins and their values could greatly decrease the time needed to teach more complex money skills, because they are assumed to serve as a prerequisite for more functional use of money (Trace, Cuvo, & Criswell, 1977).

METHOD

Participants, Setting, and Materials

Two 6-year-old boys who had been diagnosed with autism participated in the study. Paul spoke in multiple-word sentences, and Dennis spoke in two- to four-word sentences, almost all of which were prompted. Sessions were conducted in a secluded area in the participants' classroom. Materials included three coins (a dime, a nickel, and a penny), a stimulus placement board (50 cm by 19 cm) with three strips of hook-and-loop tape, and three laminated cards (5 cm by 7 cm) with the corresponding printed prices in dollar notation (\$0.10, \$0.05, and \$0.01). These cards were printed in Times New Roman 40-point font on a white background.

Prior to each session, participants were exposed to a brief multiple-stimulus without replacement preference assessment (MSWO; Higbee, Carr, & Harrison, 2000) in which the first item selected served as the consequence for that session. Each participant had a board with 10 tokens. Immediately after earning all tokens, the participant was given access to the highly preferred item.

Design, Response Definition, and Interobserver Agreement

The effects of conditional discrimination training on the emergence of novel stimulus relations were evaluated using a pretest–train–posttest sequence (e.g., Groskreutz *et al.*, 2010). The order of conditions was as follows: emergent relations pretests, conditional discrimination training, and emergent relations posttests (Table 1).

Observers scored pointing or selection responses (touching with index finger or removing picture from stimulus board) and vocal responses (tacts, textual, and intraverbal behavior) during emergent relations tests and training as either correct or incorrect. The percentage of correct responses was calculated by dividing the number of correct responses by the total possible number of responses per block. A second independent observer scored responses during 41% and 39% of the sessions for Dennis and Paul, respectively. Agreement was calculated by dividing the number of agreements by the sum of agreements and disagreements and multiplying by 100%. Interobserver agreement was 100% for both Dennis and Paul.

Procedure

Emergent relations pretests and posttests. Relations between coins and printed prices were tested before and after training using visual–visual and auditory–visual MTS tasks, tact, textual, and intraverbal tests (see Table 1). During visual–visual MTS (CB), the experimenter presented one stimulus (sample) and the participant was required to point to the sample prior to the presentation of the comparisons. The experimenter then presented three comparisons attached to the stimulus board. During auditory–visual MTS (AC, DB), the experimenter dictated the sample, asked the participant to repeat it, and then presented the three comparisons. Each session was composed of nine trials. Samples were presented three times each, and the positive comparisons were presented once on the left, once in the middle, and once on the right of the participant.

Table 1
Order of Training and Testing Conditions

	Condition	Relations ^a
Emergent relations pretests and posttests	Given dictated name, select printed price	AC
	Given printed price, select actual coin	CB
	Given dictated price, select actual coin	DB
	Given actual coin, say spoken name	BE
	Given dictated price, say spoken name	DE
	Given dictated name, say spoken price	AF
	Given printed price, say spoken price	CF
Conditional discrimination training	Given dictated name, select actual coin	AB
	Given actual coin, select printed price	BC
	Given dictated price, select printed price	DC
	Mixed training (review)	AB, BC, DC

^a A = dictated coin name (e.g., "dime"), B = actual coin, C = printed price, D = dictated price (e.g., "10 cents"), E = spoken coin name, F = spoken price.

During tact and textual behavior tests (BE and CF, respectively), the experimenter presented either the actual coin (B) or the printed price (C) and asked the participant, "What is it?" During intraverbal tests (DE, AF), the experimenter asked the participant, "What coin is worth X cents?" or "How much is X worth?" All tact, textual, and intraverbal sessions were comprised of nine trials in which stimuli were presented three times each.

All testing was conducted without the delivery of consequences and was interspersed (3:1) with mastered trials (e.g., "How old are you?"). Reinforcement for mastered trials consisted of the delivery of a token. The criterion for evidence of emergent relations was eight of nine (89%) of testing trials correct.

Conditional discrimination training. During this condition, the participant was taught in the presence of the dictated name to select the actual coin (AB), in the presence of the actual coin to select the printed price (BC), and in the presence of the dictated price to select the printed price (DC). Finally, mixed training was conducted by interspersing AB, BC, and DC trials within the same block. These relations were taught one at a time until mastery, using MTS procedures as described above. A session consisted of nine trials with each sample presented three times and the correct comparison stimulus placed once in the left, middle, and right positions. The experimenter never

repeated the sample in consecutive trials and cued responses by pointing to the correct comparison after the sample presentation using progressive delays (i.e., 0 s, 1 s, 2 s, 3 s, 4 s, 5 s). The criterion to increase the delay was two consecutive nine-trial sessions with eight of nine correct responses (89%). The criterion to decrease the delay was two consecutive errors or three total errors in a nine-trial session. Correct prompted responses resulted in praise. Correct independent responses resulted in praise and tokens. Incorrect responses (i.e., incorrect selections prior to or after the prompt, or no selection within 5 s) resulted in re-presentation of the same trial at a 0-s delay. Trials were separated by a 3-s intertrial interval. The mastery criterion for each trained relation, as well as mixed training, was two consecutive blocks with eight of nine correct unprompted responses.

RESULTS AND DISCUSSION

Prior to the beginning of the study, Paul's correct responding was 56% across all relations to be trained (AB, BC, and DC), and Dennis engaged in no correct responses for the BC relation and 33% correct responses for the DC relation. However, Dennis identified the three coins given their spoken names (AB) at 100% correct. During conditional discrimination training, Paul required 63, 54, and 45 trials to master the AB, BC, and DC relations, respectively, and

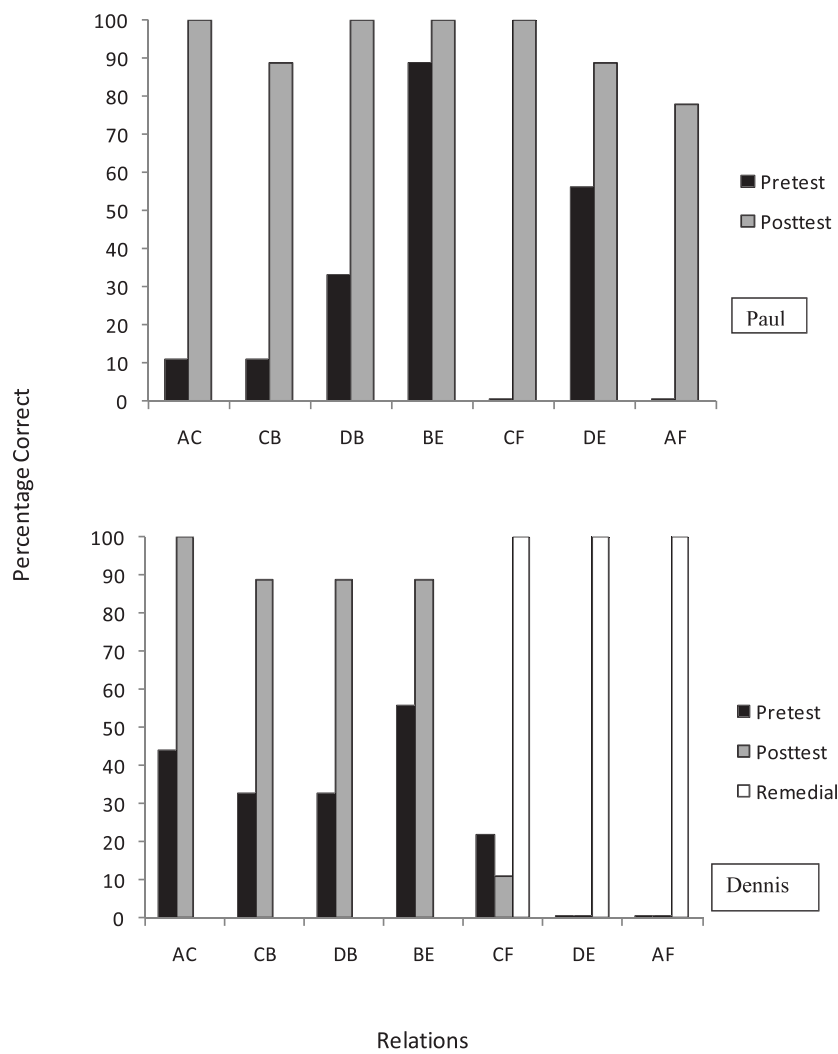


Figure 1. Percentage of correct responses across tested relations for Paul (top) and Dennis (bottom).

Dennis required 9, 72, and 72 trials to master the AB, BC, and DC relations, respectively.

Figure 1 depicts the percentage of correct responses for both Dennis and Paul during emergent relations pre- and posttests. Despite relatively high pretest scores for the BE relation for both participants and for the DE relation for Paul, scores for the remaining relations whose mastery would indicate stimulus class formation were below chance levels. All seven untrained relations emerged for Paul following training of the AB, AC, and DC relations. Of note, Paul’s performance on the AF relation was slightly

below criterion. However, given the lack of responding during pretests, his performance (seven out of nine) can serve as evidence of emergent performance.

For Dennis, four untrained relations (AC, CB, DB, and BE) emerged after training. Of the other three relations that failed to emerge, the first required that he “read” the printed price (CF), the second required that he vocally name the coin after hearing its spoken price (DE), and the third required that he say the spoken price after hearing the coin’s name (AF). Despite the fact that textual behavior (CF) has

been shown to emerge after conditional discrimination training (e.g., LeBlanc et al., 2003), listener behavior training has not commonly generated intraverbal responses (DE and CF) in the verbal behavior literature (LeBlanc et al., 2003; Petursdottir & Haflioadottir, 2009). The fact that one of the participants in the current study emitted correct vocal topographies in the presence of verbal stimuli (i.e., intraverbal) following MTS training warrants further investigation.

Dennis was taught the CF, DE, and AF relations directly because he failed to acquire them after training. Procedures during this remedial training were identical to those during testing, with the exception that after the presentation of the sample stimulus, the experimenter provided an echoic prompt in a series of five progressive delays, as described above. Mastery criterion and reinforcement procedures were the same as during conditional discrimination training. Dennis required 63, 153, and 117 trials to master the CF, DE, and AF relations, respectively. After remedial training, these three relations were maintained during probes (Figure 1, white bars).

In summary, after training three conditional relations between coins and their dictated names (AB), coins and printed prices (BC), and printed price and dictated coin names (AC), two participants with autism acquired four and seven new conditional relations without explicit training. These results suggest that the application of stimulus equivalence technology may facilitate mastery of skills that are considered to be essential for functional use of money (relate coins to their values and names) in what seems to be quite an economical way. It is important to note that, as in other stimulus equivalence research, participants who are likely to benefit from these procedures are those with well-established speaker and listener skills (e.g., Miguel et al., 2009). Future research should replicate these findings with a stronger experimental design that may rule out possible

extraexperimental learning while adding two additional classes (\$0.25 and \$1.00). Future research should also directly compare procedures derived from the stimulus equivalence literature with more traditional teaching methods.

REFERENCES

- Groskreutz, N. C., Karsina, A. J., Miguel, C. F., & Groskreutz, M. P. (2010). Using conditional discrimination training with complex auditory-visual samples to produce emergent relations in children with autism. *Journal of Applied Behavior Analysis*, 43, 131–136.
- Higbee, T. S., Carr, J. E., & Harrison, C. D. (2000). Further evaluation of the multiple-stimulus preference assessment. *Research in Developmental Disabilities*, 21, 61–73.
- LeBlanc, L. A., Miguel, C. F., Cummings, A. R., Goldsmith, T. R., & Carr, J. E. (2003). The effects of three stimulus-equivalence testing conditions on emergent US geography relations of children diagnosed with autism. *Behavioral Interventions*, 18, 279–289.
- McDonagh, E. C., McIlvane, W. J., & Stoddard, L. T. (1984). Teaching coin equivalences via matching to sample. *Applied Research in Mental Retardation*, 5, 177–197.
- Miguel, C. F., Yang, H., Finn, H., & Ahearn, W. H. (2009). Establishing derived textual control in activity schedules with children diagnosed with autism. *Journal of Applied Behavior Analysis*, 42, 703–709.
- Petursdottir, A. I., & Haflioadottir, R. D. (2009). A comparison of four strategies for teaching a small foreign-language vocabulary. *Journal of Applied Behavior Analysis*, 42, 685–690.
- Rehfeldt, R. A. (2011). Toward a technology of derived stimulus relations: An analysis of articles published in *JABA*, 1992–2009. *Journal of Applied Behavior Analysis*, 44, 109–119.
- Sidman, M. (1994). *Equivalence relations: A research story*. Boston: Authors' Cooperative.
- Stoddard, L. T., Brown, J., Hurlbert, B., Manoli, C., & McIlvane, W. J. (1989). Teaching money skills through class formation, exclusion, and component matching methods: Three case studies. *Research in Developmental Disabilities*, 10, 413–439.
- Trace, M. W., Cuvo, A. J., & Criswell, J. (1977). Teaching coin equivalence to the mentally retarded. *Journal of Applied Behavior Analysis*, 10, 85–92.

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